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Economic Aspects of Disease Control in Animals

Animal health concerns are not new to agriculture and breakthroughs occur with regularity, representing advances in technology. Likewise, the need for evaluation of new animal health technologies is not new. Standard tools such as budgeting, cash flow analysis, systems simulation analysis, and welfare analysis are required to measure benefits from new developments in animal health and disease control.

ANIMAL DISEASE CONTROL BENEFITS

Benefits derived from improvements in animal health or disease control can be diversified and far ranging, affecting producers, consumers, agribusinesses, and government agencies. Producers gain from reduced animal mortality levels, whereas diseases decrease feed efficiency, reproductive success, rate of weight gain, labor efficiency, and increased treatment and medication costs. Producers also benefit from disease control through reduced use of medication and decreased probability of self inoculation. Disease control can also reduce production variability, resulting in more uniform products and more consistent marketing times. Producer losses from farm-originated infections may also be lessened, as may losses from animal or animal product condemnation.

Improved control of diseases which are species-specific can benefit selected producers by increasing consumer demand based on the confidence that the product is more "wholesome".

Agribusinesses can benefit from improved animal disease control, as meat packers and processors would have a higher quality, more uniform product. Consequently, the time required for sorting, handling, and disposing of damaged or condemned products would be reduced, and health risks for meat inspectors, meat packers, and practitioners would be lessened.

ANIMAL DISEASE CONTROL CONCERNS

Consumers clearly benefit from improved animal disease control through lower prices, higher quality, and consistency in availability of meat and animal products. Consumers are concerned with at least four aspects of disease control which relate to product quality: safety of the product with regard to natural disease characteristics (lack of bacterial infections, zoonotic disease, etc.); safety of the product with regard to compounds added or techniques used during production or marketing (use of known carcinogens, etc.); humane treatment of animals during the production process; and the effects of disease control methods on the environment.

The methods of animal disease control influence consumer satisfaction with the product and affect overall consumption patterns. Improved disease control not only reduces the likelihood of problems created by natural disease, but also creates a positive product image. Consumers are more likely to buy a product they perceive to be free from disease or contamination, e g., poultry products free from salmonella.

While disease control techniques improve product quality in terms of organism levels, they may introduce compounds that create as much consumer concern as the disease organisms themselves. For example, meat preservatives may have carcinogenic potential, and concerns about the safety of meat from animals treated with growth hormones or food additives is everpresent.

Despite rigorous testing and careful development procedures, consumers may react negatively to products created using “new” techniques, such as gene splicing.

Many people are concerned about animal physical discomfort caused by producing animals through the use of implants, hormone treatments, etc. These factors may affect the consumer’s perception of quality or acceptability.

Environmental issues as they relate to animal disease control measures are also a concern. Antibiotic usage and residue levels in animal products and the environment have received a lot of public attention. Consumers may react to perceived environmental problems by boycotting products or attempting to alter the regulations on product use. An understanding of consumer concerns is important in order for scientists to educate the public about disease control methods, thereby avoiding adverse public response.

EXTERNALITY, DISEASE CONTROL AND SUSTAINABLE AGRICULTURE

Sustainable agriculture is defined as the development of systems which promote responsible natural resource stewardship and long-term farm profitability. Externalities have an impact on the level of sustainability and are intimately related to natural resource use since resources such as water, air, and a disease-free environment do not have clear property rights. Because property rights are not exclusive for many resources, externalities exist when producers do not consider the effects of their actions. Members of society and future generations will eventually reap the benefits and costs of current natural resource use.

Sustainable systems remain profitable through time by the careful use and management of resources. When externalities become a part of the decision making process, society's resources are used for the benefit of everyone concerned.

An externality is defined as an action by one individual that affects the level of well-being of another individual. Externalities can be both positive and negative. For example, a person polluting a stream to avoid the high cost of waste disposal does not usually consider the effects on individuals further downstream, a negative externality.

Externalities from animal disease control are of two types: externalities created by the spread of disease mechanisms and externalities created by the agents used to control disease. Society must deal with both of these off-site effects of disease control or non-control in determining optimal resource allocation.

There are many externalities in animal disease control. For example, a farmer who eliminates pseudorabies from the swine herd reduces the probability that the neighboring swine or cattle herds will become infected. On the negative side, when a pork producer allows sulfa residues to be spread in the environment through improper feeding and handling procedures, health hazards are created. The most common method of ensuring that externalities are taken into account is through quantity and pricing regulations, or changes in ownership patterns. An example of a quantity regulation is the banning of a particular chemical, while a tax on its use is a pricing method of control. Ownership can be recognized and protected through legal changes which, for example, give a downstream firm the right to clean water.

Animal disease control measures in conjunction with sustainable agricultural systems can create additional externalities and regulatory problems. The reduced use of animal health products due to genetically improved animals may reduce externalities which result from chemical residue (positive externality). Alternatively, the use of animal wastes as fertilizer in a sustainable system may increase the danger of groundwater contamination (negative externality). New disease control techniques, such as genetically engineered vaccines, may help eliminate some diseases and lead to environmental improvements (positive externality), but vaccines may delay the movement toward good management practices and increase the disease reservoir in the environment through carrier animals not showing clinical signs (negative externality). Improved diagnostic tests may reduce the need for prophylactic treatment and the use of environmentally damaging chemicals (positive externality).

Another problem in the chemical treatment of animal diseases is that animals develop a resistance to the compound over time. Furthermore, some chemicals destroy both beneficial and harmful organisms in the animal. Therefore the benefits of current chemical treatment must be balanced against chemical effects on future immunity.

Biotechnology offers the opportunity to reduce the development of compound resistance by reducing the need for chemical control through (new and improved) disease-resistant genetic material. Naturally immune animal populations are more sustainable than those dependent on chemical controls. Unfortunately, animals immune to one disease may be more susceptible to others.

Since there are no clear answers as to the effects of new disease control agents on the environment, agricultural research needs to consider both external and internal effects in carrying out cost/benefit analyses for new products.

ANIMAL DISEASE CONTROL ADOPTION ISSUES

The adoption of animal disease control technologies involves producer evaluation of a number of factors. Forces such as management intensity, the availability of information, financing, production systems, and available resources will all influence the success of disease-control technology.

Management intensity—Technological advancements will magnify the need for effective and intensive management. (Effective use of many animal health products requires improved production management and cost efficiency.) Complex technologies require a clear understanding of animal biology, integrated production relationships, disease population dynamics, epidemiology and thorough record- keeping practices. Baseline data is needed when evaluating cost- effective animal health management decisions that depend on an extensive knowledge of production levels.

Operations with inefficient management gain little from adopting disease-control techniques, while operations with top-level management will be in a position to utilize new technologies effectively. This will place a premium on management, emphasizing the differences between well- and poorly- managed operations.

Information—Large farm operations have effectively streamlined the process of gathering information and are highly specialized. In comparison, smaller producers may have difficulty staying abreast of current animal health advancements. Better communication between the private and public sectors may improve the dissemination of information, but only the highly specialized, large operations will easily internalize, gather and organize the complex information base. Other operations will need to incorporate the information base from outside sources.

Financial Concerns—Some animal health products will introduce a level of instability into the industry during the adoption and adjustment process. Superior business management skills will be necessary in order to effectively manage this instability. The successful adoption of a technology will be much more likely for operations in a solid financial position. The upfront cost of information gathering, purchase fees, and set up will have an impact on farms, depending on their size. The effective use of a product may necessitate using particular production facilities that would require remodeling to existing buildings. Survival will be difficult for those operations already in a weak financial position.

The adoption of technologies will depend partly upon a producer's ability to absorb increased risk levels. The new health management strategies may perform very well when all production factors function in unison, however, if one of the factors is out of sync, production may be dramatically reduced. This further amplifies the increased pressure for intensive management to control production variability.

Resource Quality—Animal health products may require improved resource quality and they may be more effective in certain types of production systems. The production environment may be related to product effectiveness.

Specified Products—Some animal health products may lead to the production of a specialized product, such as drug or residue-free products. The need for effective marketing to take advantage of product premiums would increase, and may require product identification from producer to consumer. Open markets typically do not handle identification and separation of specialty products well, but the need for marketing techniques such as production and/or marketing contracts may evolve.

ANIMAL DISEASE CONTROL METHODS

The basic methods of disease control include: medication, vaccination, eradication, and genetic resistance or natural immunity. In some situations medication and/or vaccination may be low-cost and highly effective. This may appear to be an easy and highly economical decision, while for others, herd condemnation with mandatory slaughter may be quite effective and economical.

When evaluating disease control and prevention programs, attention has to be given to the program's impact on the breeding herd. What may appear to be very economical and highly effective may be only a short-run phenomena. Evaluation of the system over the long-run may lead to different conclusions. For example, herd replacements tend to be selected from lines that perform best under the disease management strategies already in use. These animals perform best under vaccination, medication and eradication programs and thus reduce the expression of disease resistance (Govora and Spencer, 1983). A selected population may perform well under heavy disease control product use, but the population may not perform well if the products are withdrawn from the market.

Eradication programs have been successful for some diseases, however these tend to be costly. One method of eradication is that of depopulation or slaughtering an entire herd. The economic value of herd members that are naturally immune to disease has been overlooked by all economic studies to date. These immune animals can be used to build a replacement herd for disease resistance. The long-term economic value of these naturally immune animals may be quite high. The mandatory slaughter of breeding livestock may be eradicating multiplier animals which are not immune to a specific disease (Warner, et al., 1987).

Screening animals for disease resistance may bring economic and societal benefits. Screening could include genetic screening, serological tests, and other diagnostic tests.

ANIMAL DISEASE IMMUNITY

Sustainable agriculture has two concerns: to be economically and environmentally sustainable. Improved animal disease resistance has the potential to improve profitability and enhance the environment. Animal health is tied to animal genetics and to an animal's immune response to disease. It has been shown that the major histocompatibility complex (MHC) has an influence on an animal's immune response and disease resistance (Dorf, 1981). For example, the economic traits of chickens such as survival rate, feed efficiency, egg production, fertilization rate, hatchability and growth rate are also associated with MHC (Bacon, 1987). Lamont points to reasons for selecting for genetic resistance to disease (Lamont, 1989). Genetic resistance can lead to reduced use of vaccinations and other products as well as offering increased protection as vaccinations lose their effectiveness as a result of viral irritation. Lamont concludes that a potential exists for improving production efficiency and animal health by working with the MHC through both conventional breeding and genetic engineering.

Production traits can be positively or negatively associated with disease resistance. Govora and Spencer (1983)have indicated that it is feasible to improve disease resistance and selected production traits. However, disease resistance is typically disease specific; and information on the positive and negative relationships is needed.

ANIMAL DISEASE CONTROL COST CASE STUDIES

A National Animal Health Monitoring System (NAHMS) pilot study conducted at Ohio State University estimated annual dairy disease costs at $ 163 per cow. This included nearly $28 for drugs and biological and veterinary services (Miller, 1987). Lost milk production was estimated at $33 per cow. The University of Missouri farm business dairy results showed an average per cow cost of $40 in 1985 and $41 in 1986 for drugs and veterinary services (Bennett, 1986, 1987). The Missouri data also pointed out wide farm to farm fluctuations in these costs.

The percentage of herds and animals in the Iowa State NAHMS pilot study which had positive titers for selected diseases is shown in Table 1. While many of the herds had antibodies to several disease agents, little is known about the cost of disease in the form of reduced productive efficiency, death loss, etc.

Table 1

Percentage of herds and animals with positive titers for disease.

Positive	% herds positive	% animals positive
transmissible gastroenteritis	52	24
Mycoplasma byopneumonia	70	43
Hemophilus pleuroneumoniae	89	47
Pseudorabies	15	7
Porcine pervovirus	92	68
Swine influenza	70	43
Eperythrozoenosia	19	3
Swine dysentery	85	27

Data taken from: Owen, W. J. Initial Analysis of a Valid Food Animal Disease Database for Iowa. *Iowa State Journal of Research,* Vol. 62, No. 2, November.

The Iowa State NAHMS pilot study on swine estimated disease costs at $12,034 per farm (Owen, 1987). Annual per farm estimates ranged from $406 to $54,358. Such a wide range reflects the varying size of operations as well as the varying effectiveness of management. Monthly costs per sow ranged from a low of $1.50 to a high of $41.80. Annual disease costs averaged $8.40 per head of slaughter animal. Primary losses occurred from pneumonia ($1.26), still birth ($0.87), salmonellosis ($0.47), diarrhea ($0.47) and hemophilus ($0.33) (Owen, 1988). Since these losses represent observable losses, they are likely to be underestimated. Losses such as reduced weight gain, reduced litter size, etc. typically go unnoticed and are not considered, but for some diseases these losses may be large.

The major disease cost is "animal loss" or primary death loss. At $4.96 per head of slaughter animal, it represented 59 percent of reported disease costs ($8.40 per head of slaughter animals). The major costs from animal disease are not disease prevention or treatment costs but losses from death and reduced animal production efficiency. Therefore, greater efforts must be made to measure reduced animal productivity. Current variables that are studied overlook some of these significant disease costs.

Pseudorabies—(PRV; Aujesky's disease) is a disease of swine with a long history in the United States. Beginning in the 1970s, PRV was recognized as a major contributor to large losses in swine herds. Because of the increased severity of pseudorabies, there has been a strong effort to understand the disease, develop improved methods of control, better vaccines and diagnostic tests, and analyze the benefits and costs of eradication versus herd by herd control.

In 1984 a pilot project was begun in Marshall County, Iowa, with the intent of eradicating PRV from the county. The project also investigated the costs of three alternative eradication procedures. By using data collected from positive herds, the costs of pseudorabies outbreaks was also measured.

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Table 2

Valuation of losses due to clinical PRV.

Type of loss	cost
Term abortion	$348.66
Abortion at 3 months	340.14
Stillborn or mummified hog	37.20
Death of a baby pig	47.63
Death of a growers/finishers	56.90
Open at 60 days (sow sold)	308.97
Open at 60 days (sow rebred)	103.98
Open at 30 days (sow sold)	231.50
Open at 30 days (sow rebred)	39.16

Source: Hallam, Zimmerman, Beran." The Cost of Clinical Pseudorabies in Iowa Swine Herds", *Iowa State University, Agriculture and Home Economics Experiment Station Cooperative Extension Service,* AS-590, December 1987.

Using pilot project data, Hallam, Zimmerman and Beran (1987) evaluated PRV costs and associated cleanup costs. The cost per instance of clinical PRV is reported in Table 2. These losses were then multiplied by the occurrence probability from the sample data to determine the expected loss from a PRV outbreak.The losses are reported in Table 3. They range from $20 to $40 per sow depending on the assumptions used. The results imply that the typical 100 sow herd would differ by the sum of $2000 to $4000 from an outbreak.

Table3

Rale of losses per sow and costs due to clinical PRV.

Type of loss	rate of loss per sow	cost per sow (non-seedstock) non-replacement	replacement	cost per sow (seedstock)
Term abortion	0.030	$10.33	$6.22	$36.77
Stillbirths/mummies	0.155	5.77	3.45	18.65
Death of a baby pig	0.361	17.19	9.75	49.81
Death of growers/finishers	0.004	0.26	0.15	$0.66
Open at 60 days (sow sold)	0.008	2.47	1.38	9.52
Open at 60 days (sow rebred)	0.008	0.83	0.80	1.04
Open at 30 days (sow sold)	0.015	3.47	1.47	16.68
Open at 30 days (sow rebred)	0.015	0.59	0.57	0.72
Reduced rate of gain in survivors	0.044	0.29	0.00	0.29
Total per sow (case if sow sold)		39.78	22.42	132.38
Total per sow (case of sow rebred)		35.26	20.94	107.94

Source:Hallam, Zimmerman and Beran. "The Cost of Clinical Pseudorabies in Iowa Swine Herds," *Iowa State University, Agriculture and Home Economics Experiment Station Cooperative Extension Serivce,* AS-590, December 1987.

The costs of eliminating PRV from 23 swine herds in Marshall County, Iowa, were also estimated using Pilot Project data. Cleanup of PRV used depopulation-repopulation methods, test and removal methods and a program of controlled vaccination with offspring segregation. The details of these plans are discussed in Zimmerman et al. (1989), and the results are summarized in Table 4 on the following page.

The most expensive plan was depopulation with a per sow herd cost of $204. The most economical plan was test and removal with a cost of $7.79. The most commonly used plan of offspring segregation had a per sow cost of $40.84. While the method of test and removal was very inexpensive, it is only appropriate when prevalence within the herd is very low. The large cleanup costs, when compared with the costs of an outbreak, imply that few infected herds will have the incentive to eliminate disease from their herds unless they cannot vaccinate and have a high probability of future clinical signs. The infected producer may decide to live with PRV and not eliminate the disease since the costs of cleanup exceed the expected costs due to future outbreaks. The producer, however, does not consider the effects of this decision on the probability of his neighbor's herd contracting the virus. Eradication efforts will probably need the cooperation and financial support of many producers and the government.

Table 4

PRV cleanup costs by method.[3]

	Depopulatlon/repopulation			
	feederhog finishers n+3	farrow to finish n=1	test and removal n=5	Controlled vacci-nation with offspring segregation n=I4
Veterinary services	$0.01	$0.88	$0.54	$0.74
Vaccination-vaccine	0.00	46.88	1.75	7.20
labor	0.00	7.50	0.32	0.56
PRV Surveillance-testing & tagging	0.08	9.97	4.51	4.15
labor	0.01	0.95	0.67	0.38
Cleaning and Disinfecting	0.01	10.70	0.00	0.96
Isolation and Segregation				
facilities	0.23	8.73	0.00	0.00
labor	0.05	7.50	0.00	0.23
transportation	0.00	3.95	0.00	0.00
Downtime	0.00	106.60	0.00	0.00
Losses at sales of culled breeders	0.00	0.00	0.00	26.62
Total producer bosts	0.30	145.93	0.99	28.75
Total program costs	0.09	57.73	6.80	12.09
Total costs	0.39	203.66	7.79	40.84

Source: Hallam, Zimmerman and Beran. 'The Cost of Clinical Pseudorabies in Iowa Swine Herds," *Iowa State University, Agriculture and Home Economics Experiment Station Cooperative Extension Service,* AS-590, December 1987.

A study of a large swine production operation in North Carolina estimated PRV losses at $16.21 per sow farrowed (Kleibenstein, eta/., 1988). Losses ran for 17 weeks after the outbreak and amounted to 5.28 percent of the hogs born during the outbreak period of one to four weeks. This same study showed the losses from "high loss" disease (primarily transmissible gastroenteritis) to include 14.04 percent of the hogs born. Respiratory diseases reduced production levels by approximately nine percent. With the assumption that a typical swine operation has 7.8 hogs (U.S. average) per sow, per litter. Pseudorabies vaccine cost per hog was $2.09.

The Iowa NAHMS study showed that seven percent of the hogs had positive titers for PRV (Owen, 1987). Extrapolating to a national scale, if seven percent of the 80 million market hogs produced annually are infected with PRV, it means that 5.6 million hogs are infected. If this assumption is true and the losses associated with PRV were to be reduced by half, the cost savings would be approximately $5.9 million annually (5.6M hogs x 50% loss reduction x $2.09 [vaccine cost per hog]).

Using data from the Iowa Pilot Project and other surveys, a benefit cost analysis of a national eradication program was completed (Hallam, etal., 1987). The analysis considered the costs and benefits of a 10 year eradication plan. It was assumed that states were to follow different protocols depending on disease severity. The benefits of eradication included eliminated clinical disease, vaccination, and reduced testing costs. Nonclinical disease costs were not included since the data was not available or of questionable quality. The discounted value of these benefits was determined to be J 136.4 million using a 10 percent discount rate and $271.5 million using a six percent discount rate. The total cost of the program to producers and the government was $134.4 million using a 10 percent rate and $155.8 million using a six percent rate. The benefit cost ratio was not large, but the program has already been undertaken.

Swine slaughter check and panel—A Missouri swine panel study showed direct swine health expenditures ranging from $0.59 to $4.59 per hog (Kliebenstein, etal., 1983). Total confinement and mixed housing systems tended to have higher per hog expenses. The two leading expenses were for pneumonia and atrophic rhinitis prevention and control. This range in health expenditure costs is consistent but narrower than that shown in the Iowa State NAHMS report. The Missouri study showed that the primary disease seasons were the fall and winter quarters. Forty-eight percent of the hogs in the winter and 40 percent of the hogs during the fall were reported to have health problems.

A slaughter check study showed the two primary morbidity events in swine were pneumonia and atrophic rhinitis (AR) (Boessen, et al., 1988). Losses from pneumonia for a "batch" producer averaged $1.09 per hog. For a continuous producer, losses averaged 1.5 cents per hog, per day of $5.48 per hog production space per year. Losses from AR were $0.95 per hog in a "batch" production system and 1.3 cents per hog per day or $4.75 per hog production space per year in a continuous production system.

Biotechnology offers much to the development of sustainable agriculture. Benefits of cost effective and sustainable technology are diverse, affecting producers, consumers, agribusiness firms and government agencies. It must be recognized that some products have both benefits and costs associated with their use, and some may reduce problems while increasing others. Thus prudent evaluation is needed in both the development and use of biotechnological products.

As with many new technologies, there are no clear answers concerning a product's impact on society and the environment. Nonetheless, potential impacts require careful analysis. The potential for catastrophes must be properly evaluated if society is to bear risks that may provide only a few benefits. Socially optimal disease control measures must account for all costs and benefits—the direct as well as the indirect and external.

A review of the cost analysis of selected diseases shows that economic analysis of animal disease control alternatives are an important component of disease control policies. These costs need to be evaluated at both the societal and production level.

Producer adoption of animal disease control techniques will involve a number of factors, including management intensity, information availability, financing, production systems, and available resources. 169
These factors will affect producers in different ways, and thus costs and benefits are not likely to be distributed evenly.

Animal disease control strategies will not transform below-average managers into above-average managers, as many new technologies emphasize improved management intensity as a part of the technology package. Management strategies should be in place before a product is adopted, and this should make implementation smoother. Producers need to have healthy management in order to successfully utilize new products and technology, and appropriate management information needs to accompany the introduction of new technologies.

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